इंटरनेट मानक

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Indian Standard

(Reaffirmed 2002)

RECOMMENDATIONS FOR MEASUREMENT OF QUALITY CHARACTERISTICS FOR PISTONS

Internal Combustion Engines Sectional Committee, EDC 14; Piston Assembly Components Subcommittee, EDC 14 : 1 [Ref : Doc : EDC 14 (3361)]

1. Scope — This Standard covers in two sections, the recommended practices for dimensional measurements of pistons as applicable to internal combustion engines.

1.1 Unless otherwise agreed upon between the manufacturer and the purchaser the dimensional measurements are applicable prior to coating.

SECTION 1 PISTONS AND RING GROOVES

2. Nomenclature — Nomenclature shall be according to IS : 8503-1986 'Technical supply conditions for aluminium alloy pistons for internal combustion engines (*first revision*)'.

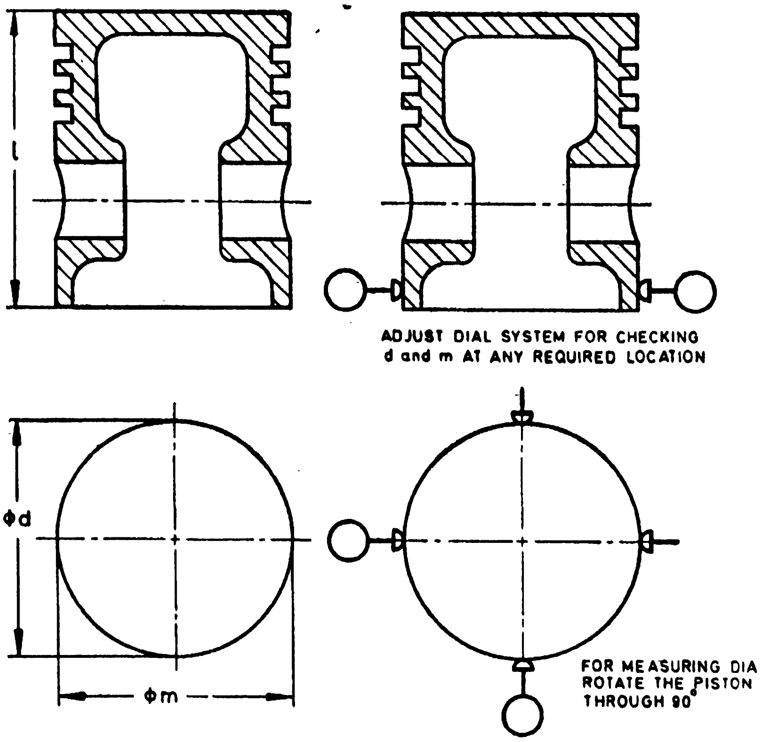
3. Quality Characteristics and Recommended Measuring Systems

3.1 *Piston Diameters* — Shall be measured after soaking the piston at a steady state temperature of 20°C for at least two hours.

3.1.1 a) *Major diameter* (*d*) — Diameter measured at right angles to gudgeon pin hole axis at any point along piston length.

b) *Minor diameter* (*m*) — Diameter measured parallel to the gudgeon pin hole axis at any point along piston length.

c) *Skirt profile* — is the diametral changes along the piston axis and can be obtained by moving the dial system vertically from bottom of the skirt to the crown of piston. Polar profile can be obtained by rotating the piston about its own axis with the dial system at the desired height. A suitable alternate profile measuring system may also be used.



ADJUST DIAL SYSTEM FOR CHECKING d and m AT ANY REQUIRED LOCATION

FOR MEASURING DIA ROTATE THE PISTON THROUGH 90°

FIG. 1 MEASUREMENT OF PISTON DIAMETER

Adopted 9 February 1987

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3.1.2 For measurements of these diameters (Fig. 1), the piston shall be placed on the horizontal table of the measuring instrument and shall be supported symmetrically against two hardened edges forming a 90°V. A Mechanical comparator with least count 0·001 mm and total range of measurement 0·100 mm shall be mounted on a floating bow mounted in a vertical column rigidly fixed on the measuring table. The plane of measurement may be oriented to pass through the piston axis by shifting the position of the V-shaped edges depending on the piston diameter.

More than one bow assemblies with comparators may be mounted on the vertical column for simultaneous multiple diameter checks.

3.1.3 The piston diameter may also be measured by a liquid column air gauge.

3.2 *Groove Root Diameter* (*g*)

3.2.1 Groove root diameter is the diameter of the groove root surface.

3.2.2 Measurement may be done by supporting the piston over a straight edge inserted into the piston groove (Fig. 2). A mechanical comparator with least count of 0·01 mm shall be used.

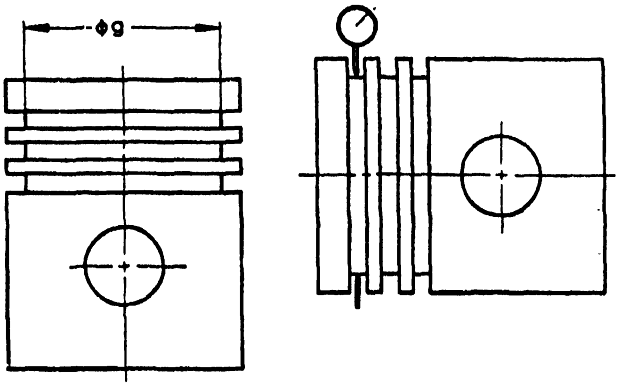


FIG. 2 MEASUREMENT OF GROOVE ROOT DIAMETER

3.3 *Groove Root Radius* (*r*)

3.3.1 Groove root radius is the radius joining the groove root surface with the side faces of the groove.

3.3.2 Measurement of radius (Fig. 3) shall be done either with a suitable radius gauge or through a shadowgraph or with a tool-maker's microscope.

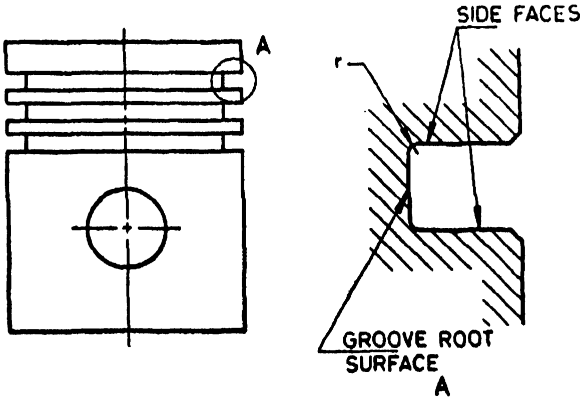
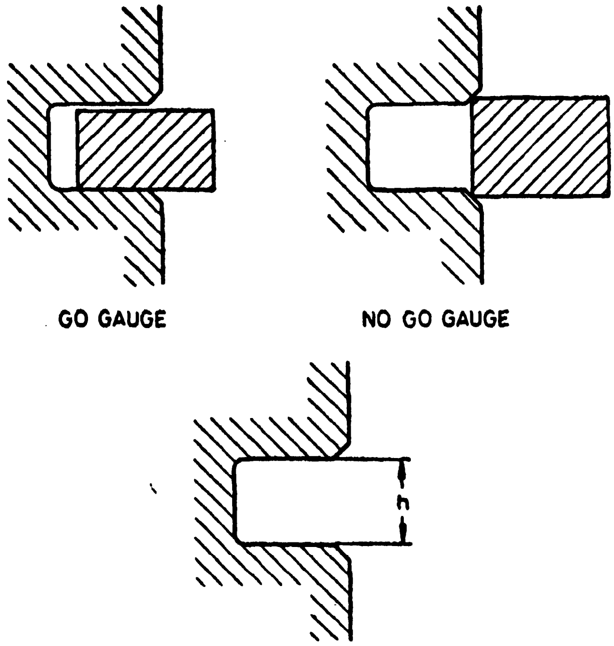


FIG. 3 MEASUREMENT OF GROOVE ROOT RADIUS

3.4 *Ring Groove Axial Width* (*h*)

3.4.1 Ring groove axial width is the distance between the side faces of a groove.

3.4.2 Groove axial width shall be measured with 'GO' and 'NO GO' plug gauges (Fig. 4). 'GO' gauge shall enter the groove freely. The 'NO GO' gauge shall not enter the groove.


GO GAUGE

NO GO GAUGE

FIG. 4 MEASUREMENT OF AXIAL HEIGHT OF GROOVE

3.5 *Piston Ovality* (*d-m*)

3.5.1 Ovality at any plane perpendicular to the piston axis shall be the difference between major diameter (*d*) and minor diameter (*m*) in that plane (Fig. 5).

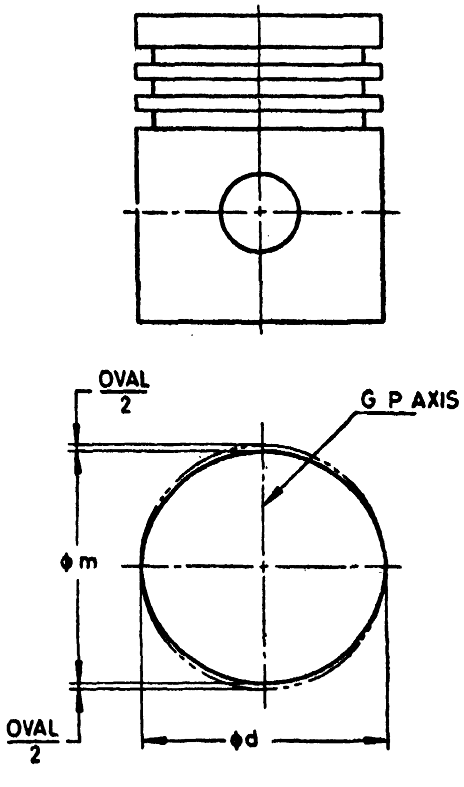


FIG. 5 PISTON OVALITY

3.5.2 Ovality shall be measured as described in **3.1.2**.

3.6 *Compression Height* (*CH*)

3.6.1 Compression height is the distance between the gudgeon pin hole axis and top most points of the crown of the piston parallel to piston axis.

3.6.2 The piston shall be supported in its gudgeon pin hole on a cylindrical mandrel having a dimension of approximately 0·020 mm less than the minimum dimension of pin hole and surface finish 0·5 µm 'CLA' (Fig. 6). The measurement shall be taken with the help of a mechanical comparator having least count of 0·01 mm.

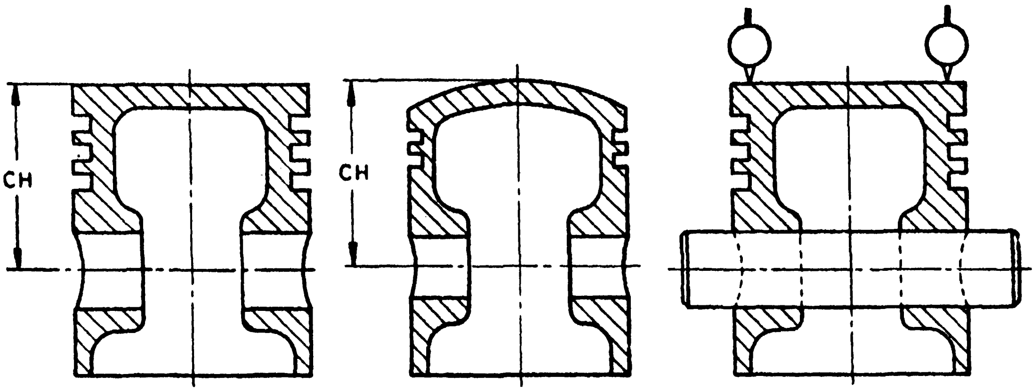


FIG. 6 MEASUREMENT OF COMPRESSION HEIGHT

3.7 *Top Land* (*TL*)

3.7.1 Top land is the distance of first groove sideface towards the crown from the crown edge.

3.7.2 The measurement shall be done with the help of a vernier caliper mounted with a mechanical comparator having a least count of 0·01 mm (Fig. 7). Alternatively, it can also be checked with a suitably designed snap gauge.

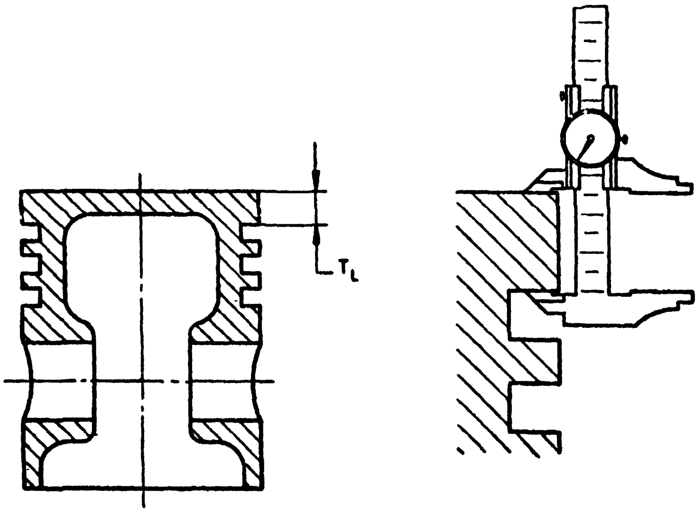


FIG. 7 MEASUREMENT OF TOP LAND

3.8 *Height of Lands*

3.8.1 t_1 — Distance between adjacent side faces of first and second groove (land immediately below the top compression ring).

t_2 — Distance between adjacent side faces of second and third groove.

3.8.2 The measurement shall be done with the help of a vernier caliper mounted with a mechanical comparator having least count of 0·01 mm (Fig. 8).

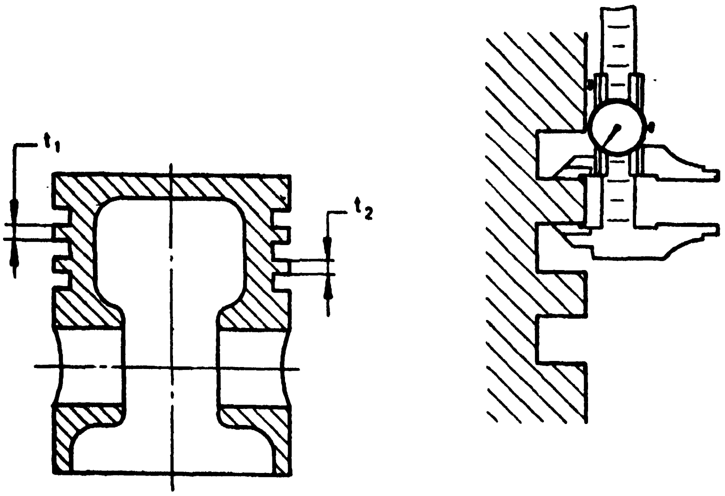


FIG. 8 MEASUREMENT OF HEIGHT OF INTERMEDIATE LANDS

3.8.3 Alternatively, a vertical height gauge may be used for the measurement.

3.9 *Crown Thickness* (*CT*)

3.9.1 Crown thickness shall be defined as the minimum distance between the underside of piston crown and the crown surface measured parallel to the piston axis.

3.9.2 Crown thickness shall be measured by supporting piston on a flat surface with its crown downwards. A depth gauge fitted with a mechanical comparator having least count of 0·1 mm is made to contact the underside of the piston crown at the lowest point (Fig. 9). In case of pistons having special crown shapes, inspection method shall be selected according to requirement.

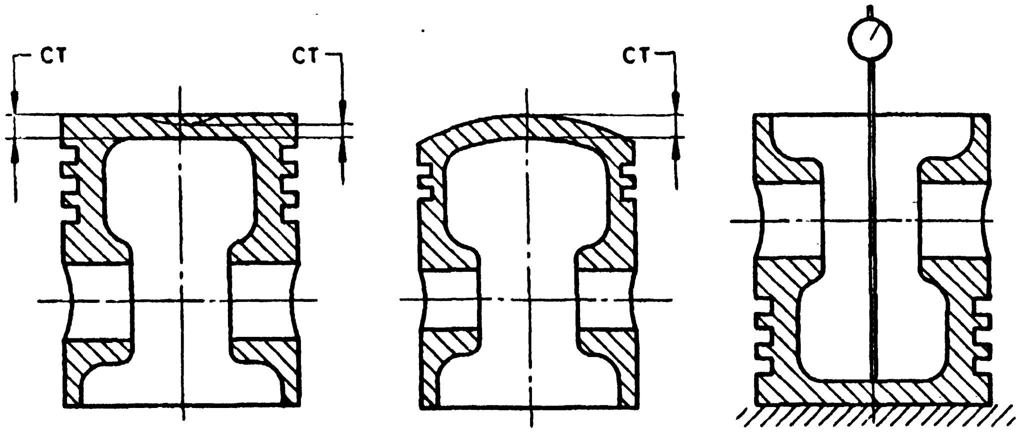


FIG. 9 MEASUREMENT OF CROWN THICKNESS

3.10 *Gudgeon Pin Boss Distance* (*BD*)

3.10.1 Gudgeon pin boss distance is the distance between inner boss faces of gudgeon pin hole.

3.10.2 It shall be measured with a 'GO' and 'NO GO' plug gauge (Fig. 10).

3.11 *Gudgeon Pin Hole Diameter* (*PH*)

3.11.1 Gudgeon pin hole diameter is the average of twelve diameter measurements taken over the entire length of the pin hole in two perpendicular planes [*see* IS : 11838-1986 'Recommendations for measurement of quality characteristics of gudgeon pins'].

3.11.2 Where specifically stipulated by the purchaser the gudgeon pin hole diameter may be the maximum or minimum of the twelve diameter measurement.

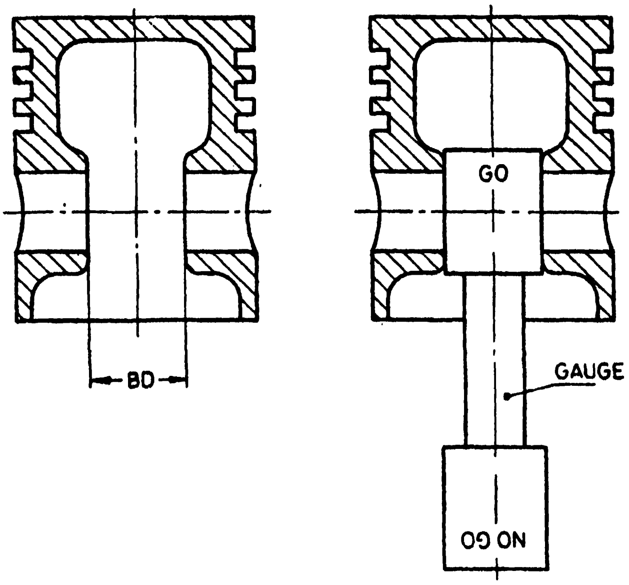


FIG. 10 MEASUREMENT OF BOSS DISTANCE

3.11.3 Diameter at any point shall be measured with the help of a special dial bore gauge having a mechanical comparator with least count 0·001 mm (Fig. 11). Alternatively, the diameter may also be checked with a liquid column air gauge as outlined in 3.1.3.

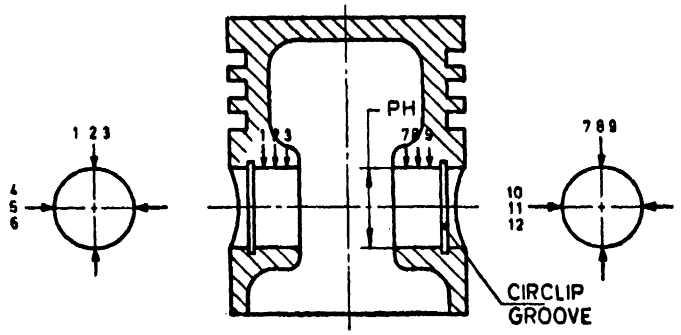


FIG. 11 MEASUREMENT OF GUDGEON PIN HOLE DIAMETER

3.12 *Circlip Groove Width (CW)*

3.12.1 Circlip groove width is the distance between the side faces of circlip groove.

3.12.2 Circlip groove width shall be measured with suitably designed 'GO' and 'NO GO' plug gauges as shown in Fig. 12.

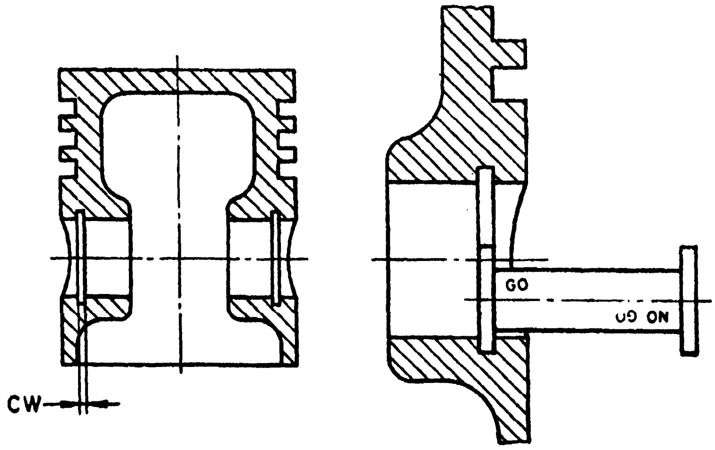


FIG. 12 MEASUREMENT OF CIRCLIP GROOVE WIDTH

3.13 *Circlip Groove Root Diameter* (*CG*)

3.13.1 Circlip groove root diameter is the diameter of circlip groove root surface.

3.13.2 It may be measured with the help of a special pair of calipers as shown in Fig. 13 or by any other suitable measuring gauge.

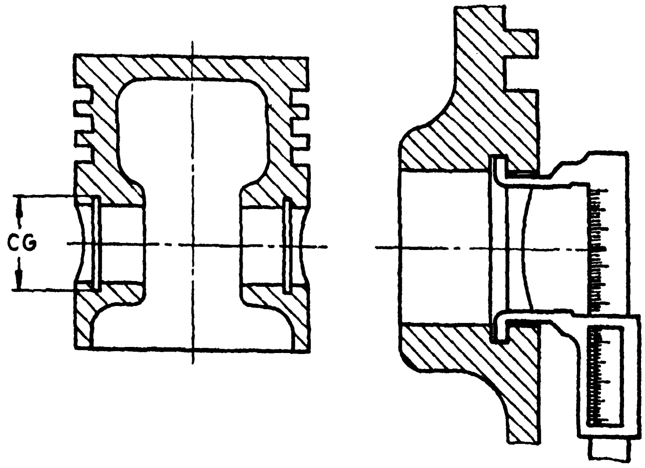


FIG. 13 MEASUREMENT OF CIRCLIP GROOVE ROOT DIAMETER

3.14 *Distance Between Circlip Grooves* (*PL*)

3.14.1 It is the distance between outer side faces of the two circlip grooves in a piston (Fig. 14).

3.14.2 Distance may be measured with 'GO' and 'NO GO' gauges or by any other suitable measuring gauge. For higher accuracies, specially designed inspection gauge equipped with a mechanical comparator of least count 0·01 mm shall be used.

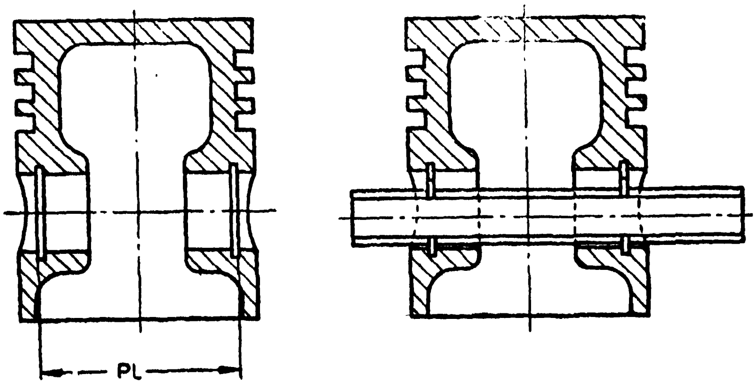


FIG. 14 MEASUREMENT OF CIRCLIP GROOVE DISTANCE

4. Geometrical Form Tolerance

4.1 *Waviness* — When measured as specified in 5.5 the waviness on the lower side face of the piston ring groove (*see* Fig. 15) shall exceed neither a double sine curve form (Sin 2 θ) nor the following values:

Nominal Cylinder Bore Diameter d_1	*Waviness Tolerance*
Up to 150 mm	0·015 mm
Above 150 mm	0·025 mm

4.2 *Wind* (*Squareness*) — The wind of groove faces in relation to the machining datum face shall be measured as specified in 5.6 and shall not exceed 0·05 percent of the piston diameter.

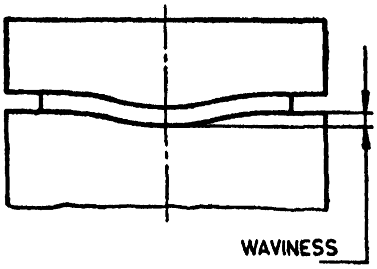


FIG. 15 RING GROOVE WAVINESS

4.3 *Ring Groove Sides*

4.3.1 *Parallel sided grooves* — The sides of grooves shall be measured as specified in **5.7** and shall be parallel within the values shown in Fig. 16.

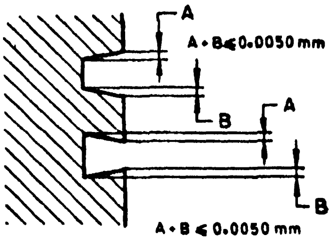


FIG. 16 PARALLEL SIDED RING GROOVE PARALLELISM

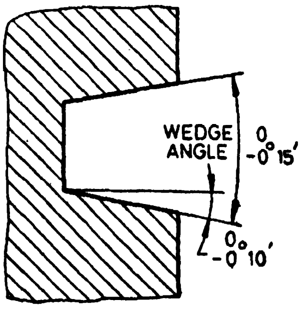


FIG. 17 KEYSTONE RING GROOVE ANGULAR TOLERANCE

4.3.2 *Keystone section grooves angular tolerance* — The wedge angle shall be measured as specified in **5.3** and shall be within the total angular tolerance shown in Fig. 17.

4.3.3 *Ring groove run* — The sides of all grooves for parallel and keystone rings shall be measured as specified in **5.8**. The amount of upward run per millimetre of gauge lengh (*see* Fig. 18) relative to the datum location face shall be within the following limits:

Nominal Cylinder Bore d_1, mm	*Ring Groove Run Tolerance*, mm
Up to 180	+0·005 −0
Above 180	+0·007 −0

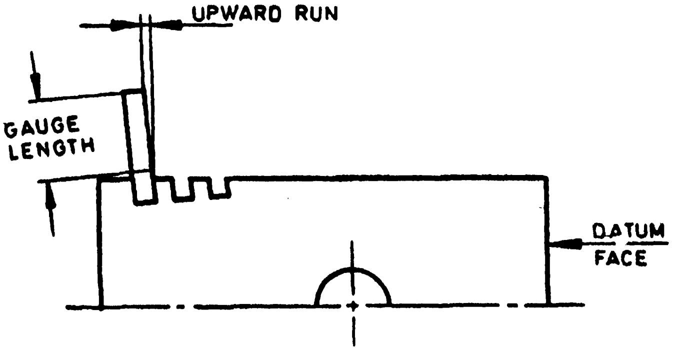
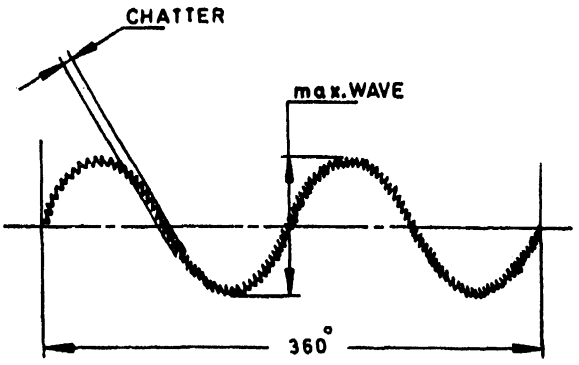


FIG. 18 RING GROOVE RUN



TYPICAL CHATTER PATTERN

4.4 *Chatter on Sides*

4.4.1 A typical illustration for chatter is shown above:

4.4.2 *Aluminium alloy pistons* — The chatter on sides of ring groove in aluminium alloy pistons shall not exceed the following:

Up to 2 mm nominal width groove	: 0·0065 mm
Above 2 mm nominal width groove	: 0·0040 mm

Note — These values do not apply to interrupted groove side faces, that is, drilling in the sides of groove side faces.

4.5 *Radii in Corners* — The radii in the corners of grooves shall be measured.

4.6 *Surface Texture*

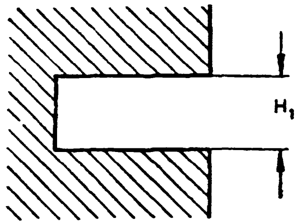
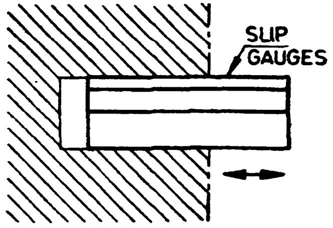
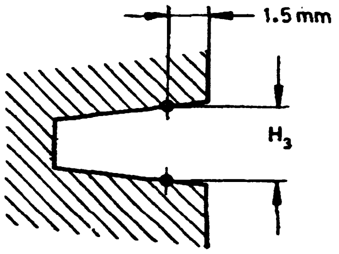
4.6.1 The surface texture of finish on the sides of grooves shall be measured radially before surface treatment, if any, and shall not exceed the following:

Aluminium Alloy Grooves: 0·4 μm, *Ra*

4.6.2 In the case of armoured ring grooves (or Alfin) where inserts of austenitic iron are cast into an aluminium alloy piston the surface texture on the sides of the grooves shall not exceed 3 μm *Ra*.

SECTION 2 MEASURING PROCEDURES

5. Characteristics — The various ring groove characteristics given shall be measured as specified below (unless otherwise stated, all values and dimensions are in millimetres):

Term	Definition	Measuring Procedure	Figure
5.1 Ring groove width H_1 (in mm)	The distance between the sides at any point around the circumference (*see* Fig. 19)	Measure at various points around the circumferance by inserting slip gauges (*see* Fig. 20)	 FIG. 19  FIG. 20
5.2 Keystone Ring Groove Width H_3 (in mm)	The axial width of the wedge shaped groove measured between two points on the side faces lying at a distance of 1·5 mm from the upper land in the axial section (*see* Fig. 21)	Measure by inserting two rollers into the piston groove and measuring across them (*see* Fig. 22)	 FIG. 21

In Fig. 22

ϕ is the wedge angle in (°)

r is the roller radius (any convenient size)

H_3 is the minimum gauge width of piston groove

D_3 is the diameter between the gauge points

h_3 is the ring width

D_1 is the minimum piston land diameter

M is the measured distance across the two rollors

Measure by inserting two rollers into the piston groove and measuring across them (*see* Fig. 22)

$$M = D_3 + \left(\frac{r \cos\phi - \frac{H_3}{2}}{\tan\phi} + r \sin\phi + r \right) \times 2$$

$H_3 = h_3 + 0{\cdot}075$ for 6° keystone angle

$= h_3 + 0{\cdot}040$ for 15° keystone angle

Calculation of tolerance for dimension M where l is the tolerances over dimensions M

x is the groove width tolerance at measuring point is as follows (*see* Fig. 23):

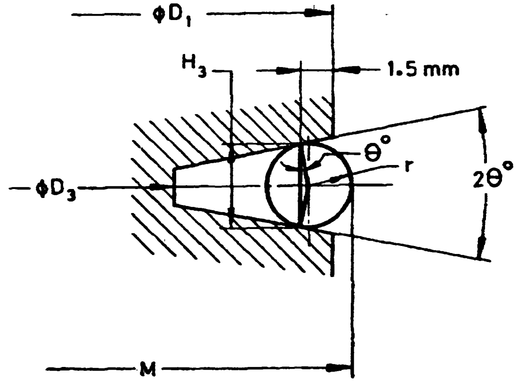


FIG. 22

An increase in the groove width x will cause a reduction 'l' in the measured distance over the roller M.

From Fig. 23; $l = \dfrac{x}{\tan\phi}$

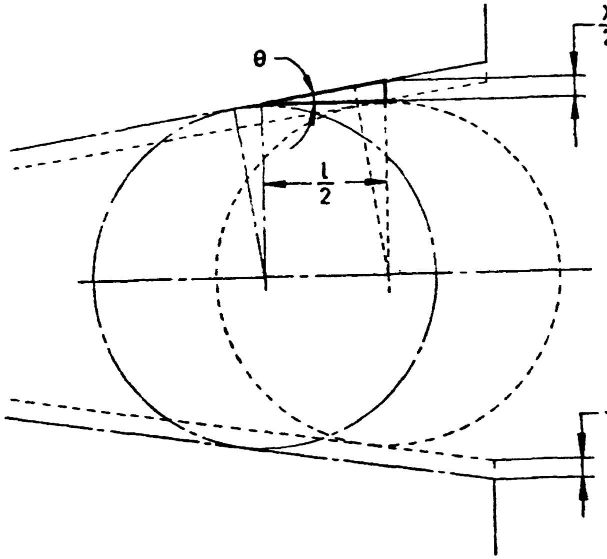
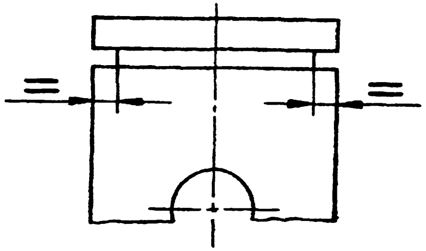
$x = 0{\cdot}025$

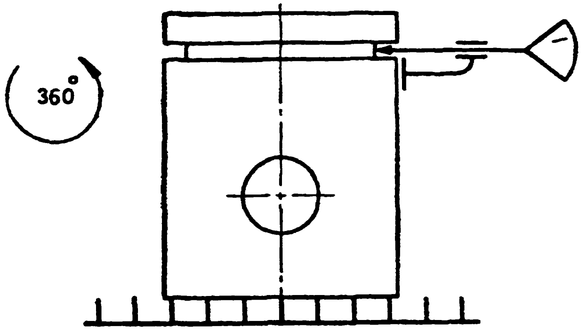
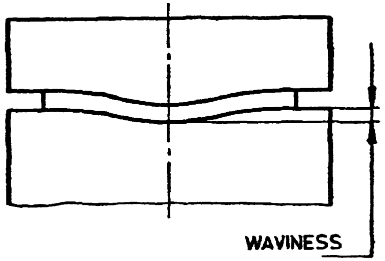
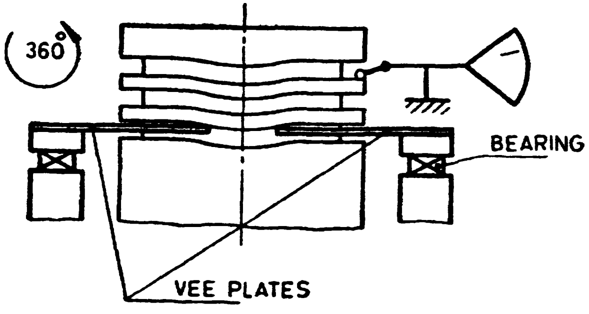
For 6° keystone: $l = \dfrac{0{\cdot}025}{0{\cdot}0524} = 0{\cdot}5$

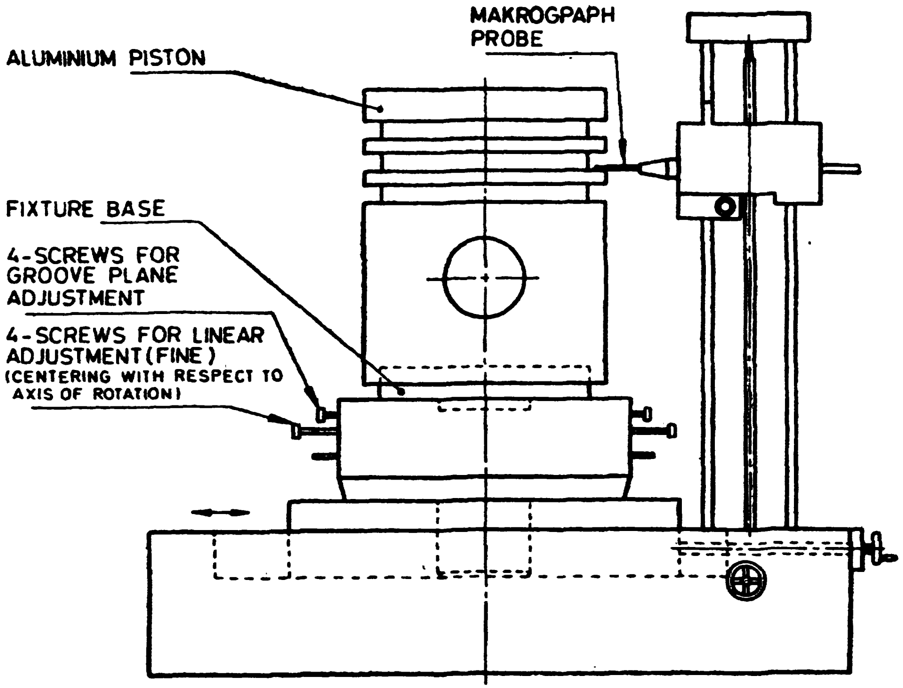
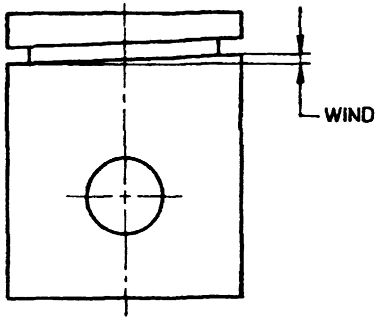
For 15° keystone: $l = \dfrac{0{\cdot}025}{0{\cdot}1317} = 0{\cdot}2$

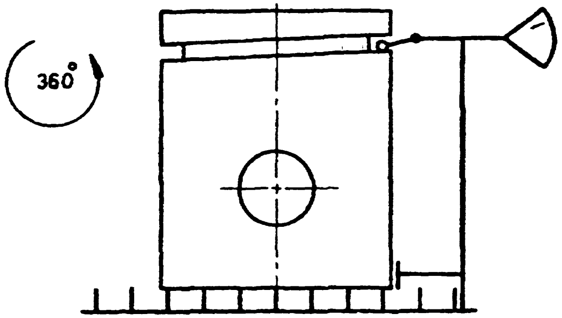
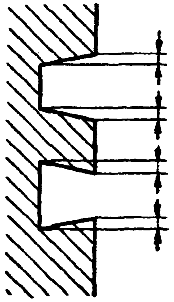
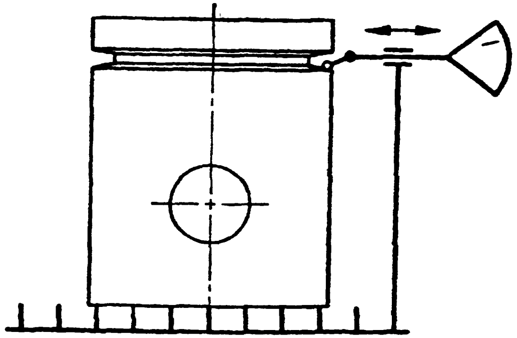
For 6° keystone $M^{+0{\cdot}000}_{-0{\cdot}500}$

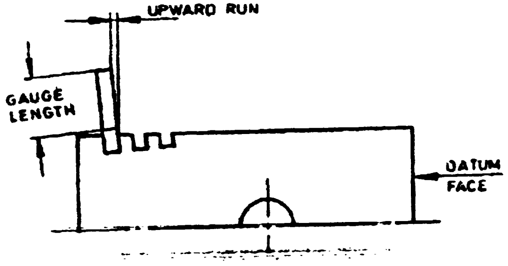
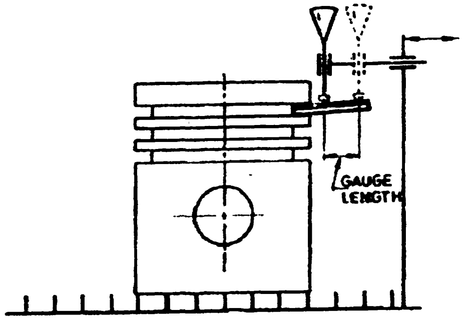
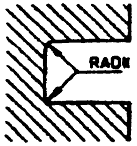
For 15° keystone $M^{+0{\cdot}000}_{-0{\cdot}200}$

Term	Definition	Measuring Procedure	Figure
5.3 Keystone ring groove included angle (in degrees minutes)	The angle between the two sides of the groove	The method of measuring the ring groove angle shall be selected by the supplier to give the required degree of accuracy. Such methods may include a shadowgraph, sine bar or the use of rollers. The sine bar and roller methods are preferred.	 FIG. 23
5.4 Ring Groove Root Concentricity (in mm)	The maximum variation in groove depth relative to the piston skirt around the full circumference and is given as FIM (*see* Fig. 24).	Measure radially to the groove root with a knife edge probe, by rotating piston through 360° with the top of the skirt as the datum (*see* Fig. 25)	 FIG. 24

		 FIG. 25
5.5 Waviness (in mm)	The maximum variation on the lower side faces of the groove relative to a datum face around the full circumference (*see* Fig. 26).	Measure on side face of groove with a spherical probe through 360°.  FIG. 26 Recommended methods are: a) as shown in Fig. 27, Fig. 27(a) b) using the piston crown or open end as the datum and rotating either the piston or the probe through 360°  FIG. 27

Term	Definition	Measuring Procedure	Figure
		 MAKROGPAPH PROBE ALUMINIUM PISTON FIXTURE BASE 4-SCREWS FOR GROOVE PLANE ADJUSTMENT 4-SCREWS FOR LINEAR ADJUSTMENT (FINE) (CENTERING WITH RESPECT TO AXIS OF ROTATION) FIG. 27 (a)	
5.6 Wind (squareness) (in mm)	The total variation of lower side face of groove relative to the datum face around the full circumference (*see* Fig. 28).	Measure with 90° cranked anvil spherical probe on lower side face of groove by rotating the piston with the skirt against a V side stop (*see* Fig. 29).	 FIG. 28

		 FIG. 29
5.7 Parallelism (in mm) **Note** — Application only to parallel sided grooves.	The radial variation of the groove width (*see* Fig. 30).	Measure at four points around the circumference, namely on the gudgeon pin axis and on the thrust axis, with a spherical probe (*see* Fig. 31).  FIG. 30  FIG. 31

	relation to open end datum face (*see* Fig. 32).	pin axis, and on the thrust axis over slip gauges as used for checking the ring groove width over a gauge length (*see* Fig. 33).  FIG. 32  FIG. 33 Measure by means of a projector/shadowgraph
5.9 Radii in Corners	*See* Fig 34.	 FIG. 34